Amendments to the Claims

The following Listing of Claims replaces all prior versions, and listings, of claims in the application.

Listing of Claims:

Claim 1 (currently amended): A method, comprising:

~~dividing a color digital image from an image sensor into a plurality of blocks;~~

~~calculating~~ determining a correlation ~~(Cor)~~ matrix (Cor) ~~of RGB~~from color values ~~channels~~ of a color digital~~said~~ image ~~sensor~~;

~~estimating~~ ascertaining a correlation matrix (Cor_{NN}) ~~for an~~of noise in the image ~~sensor noise~~;

calculating a new color conversion matrix C_{NEW} ~~using Cor and Corm, as~~ in accordance with $C_{NEW} = C_{NOMINAL}(Cor - Cor_{NN})^T(Cor^{-1})^T$, where $C_{NOMINAL}$ is a ~~second~~ nominal color conversion matrix ~~calculated for the whole picture image~~; and

color converting the color values of the image by applying ~~said~~ the new color conversion matrix C_{NEW} to ~~all pixels in a block, block by block~~the color values.

Claim 2 (currently amended): The method of claim 1, ~~wherein:~~

~~the step of~~ further comprising dividing ~~is such that said color digital~~the image ~~is divided~~ into a plurality of ~~non-overlapping NxM blocks that are each at least large enough to yield second order statistics of image signals~~image areas.

Claim 3 (currently amended): The method of claim ~~1~~2, wherein:

the ~~step of estimating is such that the~~ascertaining comprises ascertaining for each image area j a respective correlation matrix ~~(~~$Cor_{NN}(j)$ comprising values of noise variation determined for the respective image area j~~of the image sensor noise comprises a sum of the fixed pattern noise, shot noise and readout noise, wherein a variance of said fixed pattern noise and shot noise for each RGB channel depends on light intensity and is estimated from the average RGB values in a particular block~~.

Claim 4 (currently amended): The method of claim ~~1~~2, wherein:

the ~~step of the calculating is such that~~determining comprises determining for each image area j a respective correlation matrix Cor(j) having values derived from color values in the respective image area j ~~is a first correlation matrix based on said pixel values in each respective pixel group, and Cor_{NN} is a second correlation matrix based on the estimated noise of said pixel values in each respective pixel group~~.

Claim 5 (currently amended): The method of claim 1, ~~further comprising:~~

~~converting more than three color channels each with different noise statistics into a standard color space by adaptively weighing and choosing a color channel that results in minimum noise with a color conversion matrix~~wherein the determining, ascertaining, calculating, and color converting are performed on color values of the image in three or more color channels.

Claim 6 (currently amended): The method of claim ~~1~~2, wherein:

the ~~step of~~ dividing comprises grouping pixels of the image into the image areas based on local ~~is such that said pixels are grouped according to their having similar~~ statistics determined from the color values of the image.

Claim 7 (currently amended): The method of claim ~~1~~2, wherein:

the ~~step of~~ dividing comprises grouping pixels of the image into the image areas in accordance with a ~~is such that said pixels are grouped according to their having similar colors using~~ clustering process or a vector quantization ~~processes~~process applied to the color values of the image ~~to calculate the color conversion matrix for that block~~.

Claim 8 (currently amended): The method of claim ~~1~~2, wherein:

the ~~step of~~ calculating comprises calculating for each image area j a respective new color conversion matrix ~~is such that~~ $C_{NEW}(j)$ ~~is calculated via a numerical method such as conjugate gradient or steepest descent method where a starting point for C_{NEW} is~~based on the nominal color conversion matrix $C_{NOMINAL}$ or the respective new color conversion matrix $C_{NEW}(k)$ calculated for an image area k~~matrix of an~~ adjacent ~~block~~the image area j.

Claim 9 (currently amended): A method ~~of color converting a digital color picture' image made up of pixels~~, comprising:

dividing ~~the picture area of said~~a color ~~picture~~ digital image into a plurality of ~~smaller pixel~~image areas~~, each pixel having a plurality of pixel values each corresponding to a different color channel~~;

for each of the image areas, calculating a respective color conversion matrix based on the color values of the image area; and

color converting each of the image areas by applying the respective color conversion matrix to color values of the image area~~processing said pixel values for each respective pixel in each respective pixel group, using a first color conversion matrix, said first color conversion matrix being based on said pixel values in each respective pixel group~~.

Claim 10 (currently amended): The method of claim 9, wherein:

~~said first~~the calculating comprises, for each image area j, calculating a respective color conversion matrix $C_{NEW}(j)$ ~~is calculated by~~in accordance with

$$C_{NEW}(j) = C_{NOMINAL}(Cor(j) - Cor_{NN}(j))^{T}(Cor^{-1}(j))^{T}$$

wherein $C_{NOMINAL}$ is a ~~second~~ nominal color conversion matrix ~~calculated for the whole picture image~~, each of the Cor(j) is a ~~first~~ respective correlation matrix determined from color values of the image area j ~~based on said pixel values in each respective pixel group~~, and each of the $Cor_{NN}(j)$ is a ~~second~~ respective correlation matrix of noise in the image area j ~~based on the estimated noise of said pixel values in each respective pixel group~~.

Claim 11 (currently amended): The method of claim 10, wherein:

~~each pixel in a pixel group,~~ prior to ~~processing~~the color converting, each image area j has color values ($R_{j,raw}$ $G_{j,raw}$ $B_{j,raw}$) in a red, green, blue color space ~~has a first pixel value corresponding to the color channel red (R_{raw}), a second pixel value corresponding to the color channel green (G_{raw}) and a third pixel value corresponding to the color channel blue (B_{raw})~~.

Claim 12 (canceled)

Claim 13 (currently amended): The method of claim 11, wherein:

~~said first~~each color correlation matrix ~~(~~Cor(j) is determined in accordance with

~~$$Cor = \frac{1}{N}\begin{bmatrix} \sum_{i=1}^{N} R_{raw}(i)\cdot R_{raw}(i) & \sum_{i=1}^{N} R_{raw}(i)\cdot G_{raw}(i) & \sum_{i=1}^{N} R_{raw}(i)\cdot B_{raw}(i) \\ \sum_{i=1}^{N} R_{raw}(i)\cdot G_{raw}(i) & \sum_{i=1}^{N} G_{raw}(i)\cdot G_{raw}(i) & \sum_{i=1}^{N} G_{raw}(i)\cdot B_{raw}(i) \\ \sum_{i=1}^{N} R_{raw}(i)\cdot B_{raw}(i) & \sum_{i=1}^{N} G_{raw}(i)\cdot B_{raw}(i) & \sum_{i=1}^{N} B_{raw}(i)\cdot B_{raw}(i) \end{bmatrix}$$~~

$$Cor(j) = \frac{1}{N_j}\begin{bmatrix} \sum_{i=1}^{N_j} R_{j,raw}(i)\cdot R_{j,raw}(i) & \sum_{i=1}^{N_j} R_{j,raw}(i)\cdot G_{j,raw}(i) & \sum_{i=1}^{N_j} R_{j,raw}(i)\cdot B_{j,raw}(i) \\ \sum_{i=1}^{N_j} R_{j,raw}(i)\cdot G_{j,raw}(i) & \sum_{i=1}^{N_j} G_{j,raw}(i)\cdot G_{j,raw}(i) & \sum_{i=1}^{N_j} G_{j,raw}(i)\cdot B_{j,raw}(i) \\ \sum_{i=1}^{N_j} R_{j,raw}(i)\cdot B_{j,raw}(i) & \sum_{i=1}^{N_j} G_{j,raw}(i)\cdot B_{j,raw}(i) & \sum_{i=1}^{N_j} B_{j,raw}(i)\cdot B_{j,raw}(i) \end{bmatrix}$$

where i is the pixel position in ~~said pixel group~~the image area j, and N_j is ~~the~~ a respective total number of pixels in ~~said pixel group~~the image area j.

Claim 14 (currently amended): The method of claim 11, wherein:

~~said second~~each correlation matrix ~~(~~Cor_{NN}(j) is determined in accordance with

$$Cor_{NN}(j) = \begin{bmatrix} \sigma_R^2(j) & 0 & 0 \\ 0 & \sigma_G^2(j) & 0 \\ 0 & 0 & \sigma_B^2(j) \end{bmatrix}$$

where, for said pixel group, $\sigma_R(j)$ ~~σ_R~~ is ~~the estimated~~a standard deviation of noise value in the red color channel of image area j, ~~σ_G~~ $\sigma_G(j)$ is ~~the estimated~~a standard deviation of noise value in the green color channel of image area j, and ~~σ_B~~ $\sigma_B(j)$ is ~~the estimated~~a standard deviation of noise value in the blue color channel of image area j.

Claim 15 (currently amended): The method of claim ~~11~~10, ~~wherein:~~

~~said second~~further comprising calculating the nominal color conversion matrix $C_{NOMINAL}$ ~~is calculated~~ by minimizing the sum of a squared [-] difference between a spectral sensitivity function of color values in the color-converted ~~spaces~~image area and a standard color space.

Claim 16 (canceled)

Claim 17 (currently amended): The method of claim ~~11~~10, wherein:

prior to the color converting, each image area j has color values in a four-channel color space~~each pixel in a pixel group has four pixel values corresponding to the color channels cyan, magenta, yellow and white~~.

Claims 18-20 (canceled)

Claim 21 (new): The method of claim 1, wherein the color converting comprises applying the new color conversion matrix C_{NEW} to all the color values in only a portion of the image.

Claim 22 (new): The method of claim 1, wherein the color converting comprises applying the new color conversion matrix C_{NEW} to all the color values of the image.

Claim 23 (new): A system, comprising:

a memory storing a color digital image; and

a processing system operable to:

determine a correlation matrix (Cor) from color values of the image;

ascertain a correlation matrix (Cor_{NN}) of noise values in the image;

calculate a new color conversion matrix C_{NEW} in accordance with

$C_{NEW} = C_{NOMINAL}(Cor - Cor_{NN})^T(Cor^{-1})^T$, where $C_{NOMINAL}$ is a nominal color conversion matrix; and

color convert the color values of the image by applying the new color conversion matrix C_{NEW} to the color values.

Claim 24 (new): The system of claim 23, wherein the processing system additionally is operable to:

divide the image into a plurality of image areas;

ascertain for each image area j a respective correlation matrix $Cor_{NN}(j)$ comprising values of noise variation determined for the respective image area j; and

determine for each image area j a respective correlation matrix Cor(j) having values derived from color values in the respective image area j.

Claim 25 (new): A system, comprising:

a memory storing a color digital image; and

a processing system operable to:

divide the image into a plurality of image areas;

for each of the image areas, calculate a respective color conversion matrix based on the color values of the image area; and

color convert each of the image areas by applying the respective color conversion matrix to color values of the image area.

Claim 26 (new): The system of claim 25, wherein, for each image area j, the processing system additionally is operable to calculate a respective color conversion matrix $C_{NEW}(j)$ in accordance with

$$C_{NEW}(j) = C_{NOMINAL}(Cor(j) - Cor_{NN}(j))^{T}(Cor^{-1}(j))^{T}$$

wherein $C_{NOMINAL}$ is a nominal color conversion matrix, each of the Cor(j) is a respective correlation matrix determined from color values of the image area j, and each of the $Cor_{NN}(j)$ is a respective correlation matrix of noise in the image area j.